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SECOND
EASTERN FORAGE
IMPROVEMENT CONFERENCE

held at
The Pennsylvania State University
University Park, Pennsylvania
July 14-15, 1977

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SECOND EASTERN FORAGE IMPROVEMENT CONFERENCE

The Pennsylvania State University
University Park, Pennsylvania

July 14-15, 1977

Heinz Gasser, Chairman
Morris Decker, Vice Chairman
Jim Elgin, Secretary

Agricultural Research Service
United States Department of Agriculture

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INTRODUCTION

The second Eastern Forage Improvement Conference held on the campus of The Pennsylvania State University, University Park, Pennsylvania, was opened at 8:30 a.m., July 14, 1977, by Chairman Heinz Gasser. Dr. W. I. Thomas, Associate Dean, College of Agriculture, The Pennsylvania State University, welcomed participants.

The conference began with a symposium entitled "A Forage Systems Approach to Grassland Production," for which three excellent papers were presented. These symposium papers are reproduced in full in this report.

In the afternoon following the symposium, the conference participants toured The Penn State Rock Springs Agricultural Research Center. Many interesting research studies were observed.

On the morning of July 15, 10 excellent contributed papers were presented. Summaries are included in this report. The conference business meeting was held in the afternoon.

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THE APPLICATION OF SYSTEMS
ANALYSIS TO FORAGE RESEARCH

E. J. Partenheimer*

Systems analysis had its origin in operations research programs of World War II. Groups of scientists were assembled to tackle particularly troublesome military problems. Since they were unfamiliar with many dimensions of the problem, they had to acquaint themselves with all parts of an operation. In doing so, they often began to question things that military men had long accepted as fact. This questioning often led to solutions that had escaped the military men.

One problem that perplexed these scientists was that there were often so many highly interrelated parameters that no human mind could keep track of all of them. Thus an improvement in one part of a system might lead to greater problems in another part. The development of computers with large data storage and retrieval capacities opened another avenue to attack this problem. Mathematical models could be used to describe (simulate) the interrelationships between the components of the system. Although mathematical models in themselves were not new, their complexity could now be increased prodigiously because of the computational and data handling capabilities of computers. Thus systems analysis was born.

Early applications of systems analysis were in tactical and strategic planning and gaming in the military. The space program brought it into the public sector and large firms soon applied it to management problems. But the job of the manager is similar to the job of the researcher. Both operate in an environment of complex systems, both must deal with imperfect knowledge and uncertainty, and both must perform the same tasks:

1. Problem recognition and definition (hypothesis formulation)
2. Observation (data gathering)
3. Analysis (hypothesis testing)
4. Make decisions (reach conclusions)
5. Take action (publish)
6. Accept responsibility for the decisions (stand peer review. We might add that if the research is of any positive or negative consequence there will eventually be a public review.)

Thus researchers soon found that they could benefit from an application of the systems concepts to their research.

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What is a System?

Churchman(1) says that "a system is a set of parts coordinated to accomplish some goal." Note that the definition emphasizes objectives. The boundaries of a system are determined by its objectives. If an item contributes to or limits the attainment of the objectives of the system it is a part of the system. Objectives not only set the boundaries of the system but they also determine the measures of performance used to evaluate the system.

We will return to the objectives later, but first let us describe the other four basic considerations that Churchman(1) says we must keep in mind when thinking about a system:

1. System environment
2. Resources of the system
3. Components of the system
4. Management of the system

The systems environment is made up of the fixed constraints of the system. In other words they are beyond the control of the manager of the system. If the manager can do something about the item it is not a part of the environment, it is a resource of the system. If we erroneously label one of these resources as a part of the environment, we unnecessarily limit the means we can use to reach the system's objectives. The resources are the means the manager of the system uses to attain his objectives. The components of the system are the parts or subsystems of the system we are studying. The manager tries to determine the contribution of each component of the system. He must constantly keep in mind that these subsystems interact with each other, and that the performance of one subsystem affects the performance of others.

The function of the manager of a system is to control the operations of the components of a system. If systems analysis is applied to the operation of a firm the task of a manager is fairly obvious. But who performs the manager's role in the application of systems analysis to research? The researcher himself performs the managerial function. The researcher, using systems analysis, builds a system which is a model of a real world system. Although the model does not duplicate reality, it must capture the essential elements of reality. The model's objectives, environment, resources, and components must correspond with the real world situation he is modeling.

Why Use Systems Analysis in Forage Research?

Forage research was conducted for a long time before the term "systems analysis" entered our language. Even a cursory examination would lead to the conclusion that much of it was very valuable. In fact many astute researchers employed certain systems analysis concepts long before the term was used. However the conscious application of the technique would have avoided many errors and might have made the good researcher even more effective.

A major error that the systems analysis approach should help us avoid is the choice of too small of a system within which to work. Each system is made up of subsystems which are in turn systems made up of even smaller subsystems. As knowledge has expanded researchers have divided themselves into narrower and narrower fields, i.e., experts in smaller and smaller subsystems. Since we feel more comfortable working in areas in which we are expert, we may tend to define our objectives too narrowly. Let us choose a very narrow minded alfalfa breeder to pick on. He might observe very low alfalfa yields on dairy farms on a certain type of soil. Here is an opportunity for him to make a real contribution by breeding an alfalfa that would produce better on this soil type! His system, the plant itself, is too small a system to begin the analysis. He is considering present alfalfa production practices and soil conditions as a part of the environment of his system, when he should consider them as components of an alfalfa production system. Starting from this larger system he might decide that increased fertilization, alternative establishment practices, or soil drainage are much more promising routes to improved yields.

We have expanded our thinking system from the alfalfa plant to an alfalfa production system in which the plant is a subsystem. Although we are unlikely to find an alfalfa breeder as narrow minded as our first example, we might find one who thinks in terms of an alfalfa production system at times. The goal towards which he directs his efforts is increased alfalfa yields. But no farmer, except possibly some of those in five-acre alfalfa-yield contests, has alfalfa yield as a major goal of his farm business. If we expand our thinking from an alfalfa production system we open up many other alternatives, one of which might be having our alfalfa breeder work on birdsfoot trefoil. Of course we might also find that a lower alfalfa production on a larger acreage might be more profitable than higher yields on a more limited acreage.

If we continued the expansion of our horizons we would find that the first logical stopping place is the farmer himself. He is the first conscious decision maker we meet. The objectives of our system must be compatible with his objectives. Our research can contribute to the attainment of only one of his objectives, a highly constrained income maximization goal. He wants to obtain the highest income he can, subject to constraints imposed by his physical and financial resources, his skills and abilities, and the attainment of what are to him more important goals. Note that when we call the person a dairy farmer we assume (1) he has decided his goals can best be attained by devoting at least a part of his resources to farming and (2) the environment

and resources of his farm business require that a dairy herd be a major subsystem of his farm business. Forage procurement is a subsystem of the dairy subsystem. Alfalfa production is only one of many components of the forage procurement subsystem. Not only could we produce many other forages but we might purchase some of them. Of course we might meet the nutritional requirements with different forage and grain mixtures and there are alternative levels of total nutrients that might be fed. Even if the feeding system included alfalfa there are alternative levels of alfalfa production and yields, alternative cultural and harvest practices, and products with different nutrient compositions to consider. Not only are there many alternatives but the alternatives interact. The optimum selection in one subsystem affects the selection of alternatives in other subsystems. Therefore all systems must be optimized simultaneously.

To apply systems analysis to forage research our model must reflect the objectives, environment, resources and components of the system in which the users of the research operate. Failure to do so cannot only lead to research of little value but it can also lead to wrong conclusions. In the early 1950's some agricultural economists in the Northeast gathered the latest broiler feeding data from poultry nutritionists. Using perfectly correct economic analytical techniques they came to the conclusion that profits per batch of birds were maximized when broilers were fed to weights over six pounds. Under conditions existing at that time their conclusion was correct, but their recommendation that farmers feed their birds to these weights was absolutely wrong for two reasons:

1. Although feeding birds to these weights maximized returns per batch of broilers, it reduced the number of batches that could be raised per year. The added net return per batch was far less than the income sacrificed by reducing the number of batches.
2. The demand for birds of this weight was relatively small. If significant numbers of producers had followed this advice, the price for heavy birds would have decreased drastically.

These researchers had defined an objective that was different from the objective of the users of the research results. Consequently they optimized a subsystem of the system that should have been optimized.

Implementing a Systems Approach

We have seen that the first task in implementing systems analysis is to define a relevant system. The next step is to construct a model of the system. The system and thus the model will usually include many subsystems outside of any one person's area of specialization. Going back to our dairy farm example we would have, as a minimum, systems involving one or more specialities in plant science, animal science, engineering and economics. One might get the

necessary information from these fields by reviewing literature, but often mistakes are made in interpreting information from research in other fields. Consultation with scientists in these fields is a better alternative than a literature review only, but bringing specialists together to work in groups will usually give superior results for two reasons. First by bringing the person into the group he is likely to put more thinking and effort into the project. More importantly, it allows the researchers to interact with each other in a mutual learning process. If I have a question on alfalfa production I can come to you and get the question answered, but I know so little about alfalfa that there is a strong likelihood I will not ask all the relevant questions. Thus a cooperative effort by specialists from relevant fields is the ideal.

The area of emphasis will determine the detail with which each subsystem will be modeled. For example, the initial emphasis in NE-111 will be on production of alternative forages and the interaction of these alternative forages with dairy cow nutritional requirements. To do this we must of course incorporate a corn silage harvesting system. However the harvesting system will initially be modeled with less detail than the production system. We will incorporate only one or two corn silage harvesting alternatives selected on the basis of work done under NE-70.

Models of significant systems are usually so complex that they require the data handling and computation capabilities of a computer. Two kinds of models are commonly used for the types of systems we are discussing here. The first is called simulation.^{1/} We write down each relationship within each subsystem in mathematical form. We then do the same for the interrelationships between the subsystems. Relationships can be linear or non-linear and discrete or continuous. Input data can be deterministic or stochastic. Such simulators do not optimize. They only compute the results obtained from a specific set of input data. For example such a simulator could predict net farm income with a specific crop production and feeding program for a 40-cow dairy herd. We could find which of a number of such organizations gave the greatest return but we could not tell if any of them were the most profitable organization for the farm. Linear programming is the second type of model commonly used. This is an optimizing model which selects the optimum combination of a set of activities subject to a set of constraints. Despite the fact that the objective function and constraints are linear and all variables are continuous, there are techniques for both approximating non-linear functions and incorporating discrete variables. Although coefficients and constraints are constants, we can use the model to determine the effect on the objective function of alternative values for one or more of these constants. Inter-temporal relations can also be included.

^{1/} The terms "simulation" and "simulation models" are used with a number of meanings. Any good systems analysis model is a "simulation model" because it simulates the most important aspects of reality. As I have used the term "simulation" it refers only to non-optimizing models.

A systems model is verified by examining its internal logic. The question asked is, "Are the relationships expressed consistent with the theory and empirical data in the disciplines concerned with the various subsystems?" We also test the model by using input data from observable real world situations and seeing if model results compare with the actual results. Although we would expect the computed and real world results to be similar we would not expect them to be identical. The real world is infinitely complex while our models must be finite. However major divergencies mean there is a conceptual or modeling error which must be corrected.

Use of the Systems Model

One of the greatest values of systems analysis arises from the model construction and verification process itself. Hallberg and Manchester(2) state that:

Systems analysis provides us with a method of looking at the complex web of interrelationships characteristic of economic systems which could not be understood through introspection alone. . . . If we accomplish nothing more than putting such a model together, it would be useful in providing a mechanism for understanding how the complete system works--an important contribution in its own right.

The completed model also functions as a learning device and as a testing device. The first question one would likely ask is, "Which constraints and coefficients have important impacts on the objective functions?" We could parameterize these values to measure their impact on net income. This evaluation of potential impact, plus the researcher's evaluation of the possibility of attaining such changes, gives a measure of where research results are most likely to be of importance. It is a guide to where research should be done in each subsystem. In the same manner it can be used to evaluate a new alternative before time, money, and effort are devoted to developing the new subsystem. For example, a person interested in a grass for midsummer pasture might find that yields would have to be two tons of dry matter per acre after deducting for trampling and contamination losses before it could compete with stored forage. This information along with some knowledge of the yield potential of the grass would give him an idea as to whether he should work with this grass or devote his efforts to other areas.

After research within a subsystem is completed, the model can be used to determine its impact. Parameterization of prices, yields, quantities of resources, and resource ratios would show the types of situations in which the research results should be applied.

The model can also be used to measure the impact of changes in the environment of the system. For example it would measure the impact on income and farm organization of a doubling of fuel prices, a rationing of fuel or fertilizer, or the banning of a pesticide.

I believe that a conscious effort to think in terms of systems and to apply systems analysis procedures will improve the productivity of our research. As the complexity of farms increases, and as increased knowledge forces greater specialization on researchers, it becomes even more important to have a method of integrating research. I am certain that in this case the whole will be worth more than the sum of its parts.

Literature Cited

- (1) Churchman, C. W. The Systems Approach. Dell Publishing Co., N.Y., 1968.
- (2) Hallberg, M. C., and A. C. Manchester. "Strategy for Development of Systems Analytic Models--A Dairy Experience." Journal for the Northeastern Agricultural Economics Council, Vol. II, No. 2, 1973.

WHAT WOULD THE PARAMETERS LOOK LIKE

SHOULD WE RETURN TO GRAZING .

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Introduction

During the 1950's corn was reintroduced into the northeast. This introduction signalled the beginning of a trend towards an intensification in farming never before witnessed. The pendulum swung towards corn. Farms were reequipped, silos appeared, year-round feedlots developed and under many situations monoculture became a byword. Although requiring higher production energy inputs than the traditional forage crops, the relatively low cost of nitrogen, fuel and machinery and the high yield made it profitable to produce and feed silage and grain corn.

Concomitant, however, with the increased use of corn, attention was paid to the production of quality stored feed from the traditional forage crops. Production and feeding systems evolved utilizing a high grain component in rations of dairy and steer finishing. Milk production per cow increased markedly and offset the 50% reduction in cow numbers, 40% of which was attributed to the increased use of concentrates and 22% to the increase in forage quality (Reid 1977). Only the cow-calf operations remained pasture and forage oriented.

The use of high grain rations and stored feeding systems are now being examined particularly in view of the increasing scarcity and prices of fossil fuel and recent high grain prices. As well, soil compaction has become a problem with the use of heavy equipment and corn monoculture.

To assess the role pasture could play in reducing energy needs, the energy inputs of high moisture corn, corn silage, hay and pasture were estimated and were integrated into four feeding systems for finishing beef steers: 1) feedlot; 2) overwinter to pasture and feedlot; 3) overwinter to pasture and 4) overwinter to pasture with grain. The energy inputs per pound of beef were estimated on growing and finishing 400-pound steers. Assumptions were made on buildings, equipment, cropping practices and feeding systems. Rates of gain were set and the necessary feed requirements for the rate of gain were derived from those set out by the National Research Council.

Table 1. Production Energy Inputs into Growing and Finishing Steers Under Four Feeding Systems.[†]

	Feedlot	Overwinter Pasture Feedlot	Overwinter Grain on Pasture	Overwinter Pasture
Energy/lb. Beef (Kcal/lb)	3011	1908	1224	1292
Beef (lb/ac.)	857	355	472	281
Ac/Animal	0.70	1.69	1.27	2.13
Feed Costs (\$/lb)	0.27	0.28	0.20	0.23

[†]Winch, J. E. et al. 1976. Notes on Agric. Univ. of Guelph XII No. 4.

Despite the many assumptions made in these calculations, the energy inputs were sufficiently different under the four systems that some implications could be made on the role of pasture in both beef and dairy production.

The use of corn silage and high moisture grain corn resulted in a high level of energy input into beef (Table 1). However, in terms of land requirement and production per acre the "corn-feedlot" system was by far the most efficient. Approximately three times the amount of land was required to finish steers on pasture. Thus, the use of a feedlot and high energy rations may be justified in areas where arable land is scarce and high in price. The use of a partial feedlot system resulted in much lower energy inputs per pound of product than the total feedlot system.

A combination of pasture and grain on pasture, however, markedly reduced energy inputs. Grain feeding cannot be dismissed as unnecessary or inefficient. For, grain in rations on pasture resulted in a higher rate of gain; the energy input per pound of beef was as low; a reduction in pasture acres occurred and the cost per pound gain was slightly less than with pasture alone. All of these advantages agree with the findings of Mott et al. (1968), Coleman (1977) and Hendrix (1975).

As the above implications can be applied to most livestock situations, pastures and forages can be considered as a means of reducing energy inputs into beef and milk. However, in order to attain maximum returns from forages in systems good practices must be followed. Thus, the following 10 parameters should be of concern.

- | | |
|-----------|---|
| Livestock | 1. Design cropping and feeding systems for the type of livestock. |
| | 2. Set animal production levels. |
| | 3. Use proper grazing management. |
| | 4. Utilize excess production effectively. |
| Agronomic | 5. Plan for a long grazing season. |
| | 6. Choose productive species. |
| | 7. Fertilize and control weeds. |

- Land
8. Use arable and roughland in livestock programs.
 9. Use rotations.
 10. Improve roughland.

I. LIVESTOCK PARAMETERS

Requirements for energy and protein vary with the size, type and production of the animal. With cows, the requirements increase from gestation through to where the calf begins consuming additional feed. From that point to weaning, the energy requirements of a beef cow remain fairly level. As any increase in milk production requires an increase in energy and protein, it follows that the requirements of a dairy cow would be higher than those of a beef cow. As well as dairy calves are weaned early, the requirements of a dairy cow would follow the lactation curve which would peak shortly after calving. With growing and finishing beef the energy requirements gradually increase with age. Total protein requirements are not as high as those of a dairy cow.

On a herd basis, the requirements of these three classes of livestock differ. With dairy cattle, as a constant flow of milk is required, breeding will be staggered throughout the year. Thus, the cropping program must be designed to provide the necessary nutrients at a level close to the peak requirements throughout the year. On the other hand, with a beef cow herd, usually one breeding date is used (spring or fall) and a "cyclic" nutrient requirement may occur over the year. Likewise, with growing and finishing, beef requirements for growing are relatively low but marked increases in energy are required for finishing. These marked differences in animal requirement among the livestock types points to the first parameter:

Parameter 1: Design cropping and feeding systems for the type of livestock.

As there is a high nutritive requirement for dairy cattle, there is a greater need of high quality stored feed than in beef cow-calf enterprises. As a result, it is difficult to fit a dairy system to the pattern or "rhythm" of high-low crop production during the year. As such, a greater emphasis must be placed on early cutting of perennial forages, preservation as silage, the use of corn silage and the production of grain for feeding. The stored feed will be used during the period when pasture is not available and to supplement feed requirements when cattle are on pasture. Pastures consequently should be highly productive and well managed. A series of pasture mixtures to give continued supply of the quantity and quality of feed should be used.

In contrast, with beef cow-calf operations, the cyclic feed requirements can be fitted into the "rhythm" of crop production that occurs throughout the year. The necessity for high quality forage is not as important as that in the dairy industry. During early gestation a 50-55% TDN hay crop and during late gestation and early lactation a 60% TDN hay crop would be adequate for nutrition. This quality would be supplied by late cut hay (late June, early July) from a legume-grass mixture. The aftermath could be used as part of the pasture program. The higher energy requirements would occur during early spring (for spring calving) and could be supplied from early pastures as well.

If pastures were managed correctly adequate nutrition would be available until the calf was weaned in the fall. Therefore, pastures would form the major quality component of the system.

To the cow-calf system, however, should be added that of the growing and finishing of beef cattle. The addition of this component in a cow-calf program would not add greatly to the need for high quality feed except perhaps grain. The weaned calves can be carried over winter, placed on pasture in the spring and sold when pasture is short (July-August) or kept and finished with grain.

Pasture in all cases should supply all the requirements for maintenance and as much as possible of the production requirements. However, whether or not pastures will supply the energy and protein requirements for production will depend upon the level of animal production desired. This choice of the level of production is the second parameter:

Parameter 2. Set animal production levels.

With dairy it has been the practice to "go to maximum" production in North America. In Europe, farm operators appear to be more satisfied with less than maximum. Maximum production will require grain in addition to pasture herbage and with milk quotas often high milk production is justified and economical as dairy operators have a "guaranteed price." This is not true either with the beef finishing or beef-cow industry.

In addition to this complex question of the economics and energy implications of high level production, there also remains the question of herd health. It is assumed that the number of lactations over the life span of the cow is reduced with high levels of production.

It is suggested therefore that thought be given to lowering levels of production per animal in order to place greater reliance on pastures which in turn would offset the dependence on grain. This focuses attention on the potential of pasture.

Reid (1977) suggested that the ultimate output of milk possible from pasture or forage would be 34 kg per day (74 lb.). This would require a 70% D.E. forage and be consumed at a rate of 3.3% of body weight. With growing and finishing cattle a level of 1.25 kg/day (2.6 lb.) of body weight is possible on an all-forage diet. There is no doubt that a 1000-pound beef cow could produce the necessary milk for a calf on good quality pasture. These upper limits therefore should be in place and it must be managed properly. It is known that the digestibility of forages decreases with maturity. In all cases where herbage is grazed at the proper stage (approx. 8-10") the digestibility is approximately 70 to 75% IVD with a protein content of about 25%. If it were possible to present forage to the animal at this level, the upper production limits could be attained.

Presenting herbage to the animal at this stage or level is complicated and suggests the third parameter.

Parameter 3. Use proper grazing management.

It is suggested that some selectivity be permitted to the animals in any one grazing. By so doing the probability of maintaining a production level would be greater as Hardison et al. (1954) suggested that some selectivity in grazing would increase energy intake by 10-25%. However, the selectivity permitted should not be as great as to lower productivity on an acre basis to any great extent. The degree of selectivity permitted therefore must be a function of "grazing judgement" by the operator, adequate planning and pasture management.

Grazing judgement involves the number of animals, when animals should be placed on and removed from a pasture. Planning is concerned with the development of a pasture system including fencing. Pasture management includes fertilizing application, clipping and harrowing.

Parameter 4. Utilize excess production effectively.

In operations where pastures are integrated with crops on arable or machine land, the excess can be harvested as hay or silage and used as part of winter feed or as a "feed back" during the short pasture season of July and August. This production which is in excess of that required by the production herd could serve as a means of expanding from a beef-cow to a beef stocker operation. The calves could be overwintered at a reasonable rate of gain and fed this excess during May and June. When the pasture becomes short, the cattle could be "sold light" or grain could be fed to decrease pasture consumption and cattle could be finished; a greater efficiency of land use, cost per pound gain and a reduction in the time to finish cattle would occur.

II. AGRONOMIC PARAMETERS

The length of the grazing season varies considerably from north to south. In Ontario and the northern states of United States the period of grazing varies from 120 to 180 days. In the more southerly regions the period may extend up to 225 days in Missouri (Matches and Tevis 1973) to 365 days in the far south. However, regardless of the length of grazing seasons throughout the continent there is a need to provide adequate quantity and quality of herbage from pasture over the grazing season.

This will involve developing a pasture program or system which consists of a series of mixtures or crops that will provide the quantity and quality of feed over the longest period possible within any geographical area. Usually such a plan requires the development of a "core" pasture on which the cattle are grazed for most of the season and the provision of early and late forage mixtures or other crops. This sets the fifth parameter.

Parameter 5. Plan for a long grazing season.

Any extension of the grazing season into early spring and late fall imposes two problems; the restriction posed by soil conditions and the

provision of feed during periods when production from the commonly available species is either limiting or nonexistent. Animals should not be allowed on land that is "wet" in the early spring or late fall. Land that is to be used for early or late pasture must be well drained.

Few species save fall wheat, fall rye, fall rape and kale and some perennial grasses produce during these periods. Fall wheat is a cash crop and as spring grazing can be detrimental to yield of grain, this crop should not be used during this period. Some grazing could be obtained in the fall. Fall rye can provide excellent grazing from early April in the northern regions. This crop could be grazed in the fall. Crops like rape and kale will provide excellent fall pasture. The major disadvantage of these crops, however, is that if their production is intended for pasture only, they would require the use of arable land for most of the year - no other crop could be produced on the land.

Parameter 6. Choose productive species.

In order to be economical and provide feed at low cost, high production is necessary. Thus, legumes should be the basis of all mixtures in the program. They provide midsummer production and generally result in higher intake and higher rates of gain than grasses (Lechtenberg et al. 1975). There are areas, however, where legumes may not be available and grasses will have to be used. Although production from grasses can be economical (Sheard 1976), the use of grass will increase the energy input into production markedly. They require from 40 to 60 kg/ac nitrogen per year and fossil energy required to manufacture nitrogen ranges from 20 to 24 Mcal per kg (Reid 1977).

There are two major legumes for use in the pasture programs in the northeast; alfalfa and birdsfoot trefoil. Each of these species have characteristics which make them useful. Generally alfalfa is "short lived" under pasture conditions and will cause bloat. However, the high yield and early spring growth and midsummer production (Table 2) make the species one of the first to be considered. Alfalfa is adapted and used in the northeast where soils are well drained and near neutral. Alfalfa should be used primarily where high quality winter feed is required but can be utilized when aftermath pasture is decreased. Experiments at Guelph indicated that grazing or clipping early in the spring and in the fall was detrimental to persistence (Fulkerson 1976). Alfalfa fits into the crop rotations and under hay/silage aftermath pasture management systems alfalfa will persist sufficiently long to satisfy the requirements of the rotation.

Birdsfoot trefoil is a key legume on imperfectly drained soil or on land where long-term pastures are required. It does not cause bloat, has a reasonable production during the midsummer but yields about 20% less than alfalfa on "good" alfalfa soil (Table 2). The domestic varieties such as Empire, Leo or Carroll do not produce in early spring and must be considered for midsummer and fall production of stockpiled forage. Matches (1976)⁺ reported that Cascade, a European type variety, performs better for "stock piling" than Leo or Empire in Missouri. Trefoil remains green and reasonably high in quality in the fall after growth stops in mid-September.

⁺Personal communication.

Table 2. Distribution of production of some perennial forages at Guelph.

	lb D.M./Ac.		
	Early Pasture May 20	Hay July 15	Pasture Oct. 15
Alfalfa	1950	4260	2400
Birdsfoot Trefoil	570	4080	2400
Brome	2550*	5040*	1950
	1248**	862**	384
Tall Fescue	1460*	2800*	2270
Orchard	1050*	3160*	1400

* 75 lb/ac N.

**No nitrogen applied.

Trefoil or alfalfa may not be used in all locations or under all conditions. They do not produce or persist under shallow soil conditions (Watkin and Winch 1974). Crown vetch appears to be better adapted to these situations. Recent work at Guelph indicates that cicer milk vetch (Astragalus cicer L.) may be suited to such situations. It has a high yield, is earlier in growth in the spring and has a wider range of adaptability to soil drainage conditions than crown vetch. Astragalus glycyphillis L. also appears to have merit under very dry soil conditions.

The use of grasses should not be dismissed for they provide the best method of preventing weed encroachment into pasture; they do not cause bloat and in general begin growth earlier in the spring than most pasture legumes.

Southern brome grass (Cv. Saratoga) is productive early in the spring if nitrogen is applied. In contrast, tall fescue is somewhat less productive in the spring than brome but provides higher yields of quality pasture in the fall (Table 2). Tall fescue has been recognized as an ideal grass for stockpiled pasture in many southern areas (Matches and Tevis 1973). Other grasses such as perennial ryegrass, meadow foxtail and creeping foxtail have produced very well in the spring under preliminary test. Altai wild rye and intermediate wheat grass have produced as much stockpiled pasture as tall fescue in Guelph (Winch 1976).

Any grass chosen to extend the season should be included in mixtures with a legume and a suitable management system applied to insure the maintenance of both species. Tall fescue, reed canary and southern brome grass under a hay management system were found to be too aggressive for Empire trefoil. However, managed as early pasture, late hay and late stockpiled pasture, both species were maintained in the mixture. The spring growth was primarily grass and the aftermath consisted mainly of trefoil. A reasonable proportion of grass to

legume occurred (40-60) in the stockpiled feed. The quality of each of these mixtures at each period of the year was reasonably high (Table 3).

Table 3. Trefoil-Grass Mixtures for Early and Late Pasture, Guelph, Ontario.

Mixture	Pasture to mid-May		Hay mid-July		Stockpile mid-Oct.	
	(lb/ac)+	(%IVD)	(lb/ac)+	(%IVD)	(lb/ac)+	(%IVD)
Empire with:						
Tall Fescue	1570	73.1	3100	59.3	2540	65.8
Reed Canary	1670	76.3	2750	60.3	1790	60.9
Brome	1900	78.9	3030	58.8	1900	58.1

⁺Average 4 stations 2 years.

On this basis, a mixture - management scheme could be envisaged as part of a cropping and feeding system. Such a management system, however, would necessitate the use of arable land.

The use of mixtures of legumes and grasses alone will not guarantee high production. Legumes provide nitrogen but not potassium and phosphorus. In addition in many areas lime may be necessary. Soils must be limed where needed and levels of phosphorus and potassium should be applied.

As well, broadleaf weeds do invade stands of pasture, particularly in long-term pastures or if they are overgrazed. Research has shown that the inclusion of a grass will retard this invasion (Anderson and Winch 1974). Clipping and/or herbicides should be employed to control weeds. These two aspects suggest the next parameter.

Parameter 7. Fertilize and control weeds.

III. LAND PARAMETERS

Agriculturally, land has been classified into land use types. There are two broad groups of land that are colloquially termed "machine" and "animal". Both types of land should be considered as part of the total crop and feeding program. This suggests the eighth parameter.

Parameter 8. Use arable and roughland in livestock programs.

Under the Canada Land Use classification "machine" land is considered to be composed of classes 1, 2 and 3. There are no restrictions to the use of modern machinery. The land is considered to be the most productive and offers the flexibility of growing cereals, corn and forage crops.

Machine land has an opportunity value, and the inclusion of forages and, in particular, pasture must be justified on the basis of returns of forage crops to other crops that can be grown in the area (Petritz 1975).

However, despite the fact that in most cases, pasture will result in lower returns than other crops, there is a complementary value which for the most part has been ignored in this area of intensification of farming. Forages improve soil tilth, add fertility and prevent erosion. In addition, there is a potential saving in input energy that can be achieved through the use of forage crops or arable or machine land.

In view of these considerations it is suggested that greater attention should be paid to rotations. This suggests the ninth parameter.

Parameter 9. Use Rotations.

A rotation would permit stored feed to be produced (corn silage, hay or hay crop silage) which is needed for most livestock feeding systems in the northeast. In addition, grain could be purchased for feeding or for sale depending upon prices. Likewise, the use of various crops would tend to offset the alterations that do occur in the opportunity values of any one.

It is feasible to arrange a series of forage mixtures that would provide hay and/or pasture within the rotation. Likewise within the series, mixtures could be devised to provide early and late pastures. Such mixtures would be short-term and be composed of high-yielding legumes and grasses.

In contrast to machine land, the animal land (classes 4, 5 and 6, Canada Land Inventory) cannot be used for the production of grain or intertilled crops. There is much land of this type in the northeast. There is no opportunity value. Production must be from forage and utilized through grazing livestock.

At present the productivity from this type of land is low and the distribution of production from the native species is poor. Sixty percent of the total yield is produced in May and June (Table 4). This land has a much higher potential following improvement.

Table 4. Distribution of Production from Unimproved and Improved Natural Roughland Pastures, Ontario.⁺

	lb/ac D.M.	
	Mid-May and June	July - end August
Unimproved	1083	635
Improved (Trefoil)	2695	2199

⁺Average 24 locations over 4 years.

Parameter 10. Improve roughland.

The use of animal land, however, will not be without problems. The inability to use modern machinery and equipment will create problems in the improvement, in fertilization, weed control and the clipping of pastures. Likewise, fencing will be a major concern.

Methods are available for "chemical improvement" of this type of land. However, much more research is needed in this area. Under some situations the use of renovator drills can be used. Under severe conditions, oversowing methods must be employed. At the present time both of the methods of establishment are less reliable than the conventional techniques. Less costly, simple oversowing techniques employing grazing livestock should be investigated. Preliminary work has shown that a satisfactory establishment of birds-foot trefoil can be obtained under conditions where heavy grazing has been employed during the establishment year (Table 5).

Table 5. Grazing on Establishment of Trefoil - Guelph.

Plants/sq. ft.

Grazing	Dalapon	No Dalapon	Ave. ⁺
Heavy	45	23	34
Light	9	11	10

⁺Average 3 locations.

Likewise these lands; contain many species of perennial weeds; are low in fertility and in eastern U.S. the soils are acid. Overcoming these problems will require new methods and perhaps equipment for the application of lime, fertilizer and weed control.

The use of aircraft for applications of fertilizer and broadleaf herbicides may be feasible if the area to be improved is sufficiently large to justify the use of an aircraft and sufficiently remote to permit the aerial application of herbicides.

SUMMARY

Ten parameters have been derived which depict three major areas of concern: livestock, agronomy and land. Each parameter is an important component of developing the pasture program of a cropping and feeding system if we should return to grazing or if we are to place a greater reliance on pasture in the production of milk and meat. The overall objective of the system should be to provide the quantity and quality of feed.

Parameters

- | | |
|-----------|---|
| Livestock | 1. Design cropping and feeding systems for the type of livestock. |
| | 2. Set animal production levels. |
| | 3. Use proper grazing management. |
| | 4. Utilize excess production effectively. |
| Agronomic | 5. Plan for a long grazing season. |
| | 6. Choose productive species. |
| | 7. Fertilize and control weeds. |
| Land | 8. Use arable and roughland in livestock programs. |
| | 9. Use rotations on arable land. |
| | 10. Improve roughland. |

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In an attempt to project what forage production might be 20 years from now or around the year 2000, my approach will be 1) to review the importance of forages in today's food supply, 2) to assess the expected demand for food and forages in the future, 3) to review important economic relationships associated with forage production and utilization, and 4) to project how these factors might interact to influence forage production over the next two decades.

Forages are vegetative parts of plants consumed by animals. Nearly 100 different plant species contribute to forages utilized in the United States. The more traditional forages, such as grass and legume hay, silage, rotation pasture, permanent pasture, and range are well known to many of us. We are generally less familiar with crop residues and by-products of the food and feed industries, but they can be important sources of forage in certain regions of the country. As agronomists, our immediate concerns are frequently associated with the production, management, physiology, or breeding of the forage crop. However, we cannot forget that forages have little value until they are converted by ruminant livestock into edible products. Utilized in this way, forages have a tremendous economic value and can contribute to the world food supply.

Demand for Food

It is impossible to adequately evaluate the future values of forage production without considering the overall food and feed production and utilization system in which forages revolve.

It has been said that there are only two absolutes in our society -- death and taxes. Over the next few decades it is safe to include a third absolute; increasing worldwide demand for food. We have all heard of various projections of world population growth and subsequent food shortages. A generally accepted estimate is that world population will be 6.5 to 7 billion (vs. approximately 4.5 billion now) by the end of this century (National

¹ Invitational paper presented at the 2nd Eastern Forage Improvement Conference Symposium: A Forage Systems Approach to Grassland Production, held at The Pennsylvania State University, July 14-15, 1977.

² Journal Series Paper No. _____ of The Pennsylvania Agric. Exp. Sta., Univ. Park, PA 16802.

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Science Board 1974). Achievement of "zero" population growth in the next 15 years would still result in an ultimate population 2.5 to 3 times larger than at present. In its Third World Food Survey, FAO (United Nations Food and Agriculture Organization) concluded that one-half of the world population suffered from hunger, malnutrition, or both (FAO, United Nations 1963). Increased per capita demand for agricultural products by undernourished peoples (Handler 1975) along with population growth was estimated by a University of California food task force to require a near doubling of current world food production over the next 25 years (Hodgson 1976b).

Forages and the Food Chain

Although humans are frequently considered to form the apex of the food pyramid, other major components such as ruminant and nonruminant animals, seed and grain crops, and forages provide the base that supports that apex. This fact is represented diagrammatically in Figure 1. We have already noted that forages do not support human nutrition needs directly, but are consumed by ruminants which are subsequently consumed by humans. Grain crops, on the other hand, are consumed by ruminant, nonruminant animals and humans. Of all the components represented in the food pyramid, only nonruminant animals can potentially be removed without causing an immediate collapse of the food production system. Elimination of nonruminant animals as a source of animal protein would require major changes in food consumption patterns in developed countries. This could probably be accomplished over a several-year period without seriously disrupting the quantity and nutritional quality of the total food supply if present day feed grain production were shifted to production of food grains. The other components of the food pyramid, grain crops, forages, and ruminants will be an essential part of the world food supply through this century and probably much longer. The importance of forages, and therefore ruminants, in future world food supplies becomes clear when one considers present day and projected agriculture reality.

Current Forage Production and Utilization

Large land areas of the United States are presently devoted to the production of forages (Table 1). Much of the permanent pasture and rangeland (244.6 million hectares) is not suited for grain crop production because of physical, edaphic or climatic limitations. These lands are best used by continuous management for forage production.

The importance of forages in our economy is further stressed by the fact that a large land area suitable for grain crop production in the United States is devoted to the production of hay and cropland pasture (Table 1). Almost as much grain cropland was devoted to forage production (60.8 million hectares) as to grain production (63.5 million hectares).

On a broader basis, every major region of the world except Europe has more land permanently devoted to forage production than to crop production (Table 2). In addition, much of the cropland throughout the world is farmed in rotations that include forage crops as part of the rotation. It can be argued that some of the benefits of crop rotations could be maintained by changing from legume forages in the rotation to edible seed producing legumes.

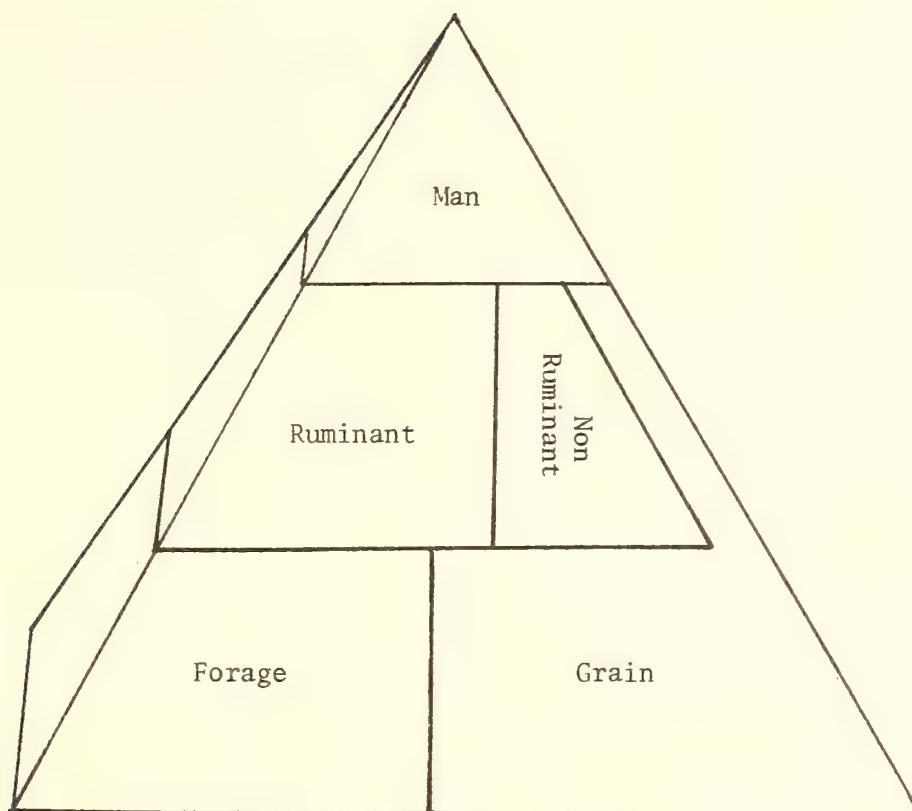


Figure 1. Diagrammatic food pyramid representative of developed countries.

Table 1. Land use for forage production in the United States, 1973 (Adapted from data presented by Hodgson 1976b).*

Forage	Million Hectares
Corn silage	3.5
Hay (all)	25.2
Cropland pasture	35.6
Permanent pasture & range	<u>244.6</u>
Total	308.9

*Total land use for grain crop production was 63.5 million hectares.

Table 2. World land use for crops and forage production (Adapted from data presented by Hodgson 1976b).

Country	Cropland	Permanent Meadows and Pastures*
		Million Hectares
Africa	209	797
North & Central America	273	353
South America	87	385
Asia	482	537
Europe	144	91
Oceania	47	468
USSR	232	375
USA**	190	244
World Total	1,475	3,005

*Includes rangelands, but not forestlands that may be grazed.

**Also included in North and Central America.

However, production and utilization of such crops would require more intensive management, new market structures, and significant changes in food consumption patterns. Although changes in this direction will probably occur in the future, it is not likely to happen in the next 20 years.

The importance of forages to our economy is not overstated by figures on land use. Production and utilization data support land use information. H. J. Hodgson (1976a) recently calculated that 27% of the food nutrients consumed by the average American each year have their origin in forages. With increasing demands on grains for world markets and subsequent substitution of high energy forage for grain in ruminant diets, it is likely this percentage will increase. Beef and dairy animals, the primary consumers of forage, supply more than half the protein consumed per person in the U.S. In addition, they supply to humans about 33% of the total energy intake, 50% of the fat, 80% of the calcium, 62% of the phosphorus, and significant quantities of other minerals and vitamins (Hodgson 1976b). It is clear from these figures that forages and their ruminant "partners" play an important role in today's economy. How can we expect this relationship to change over the next two decades as worldwide pressure increases for more human food?

Frequently in reports dealing with present and future world food requirements, discussions center around reducing animal numbers and increasing production of grain for direct human consumption. To the uninformed, animals are considered "wasteful" elements of the human food chain. More grain production will certainly be needed for more food. However, reducing ruminant animal numbers will limit food supplies, not increase them.

We have already noted that significant land areas in the U.S. and the world are likely to remain in forage production due to various physical limitations. We have also seen that large cropland areas in the U.S. are devoted to forage production. The ability of forages to compete with grain for these lands will depend on several production factors. Four major considerations are: 1) Future demand for animal products, 2) comparative dry matter and nutrient yield ability of forages and grains, 3) comparative energy cost of forage and grain production, and 4) efficiency of conversion of forage nutrients to edible animal products.

Future Demand for Animal Products

The demand for animal products of meat, milk, wool, and hides and for food and feed grain will undoubtedly increase throughout the world due to increases in population. In addition, per capita consumption of these products has been projected to increase worldwide (Handler 1975).

Table 3 presents data showing recent trends in production of livestock products in the United States. A high demand, as indicated by the 1972 production level, exists for milk and beef. The 36% increase in demand for beef suggests a per capita rise in demand of nearly 0.5 kg per person per year over the next decade (Wedin et al. 1975). Production of nonruminant animal products also increased dramatically over the 1963 to 1972 period, pointing out that demand for feed grain will also increase.

Table 3. Trends in production of livestock products in the U.S. from 1963 to 1972 (Adapted from statistics presented by Wedin et al. 1975).

Commodity	1972 Production (10 ⁶ kg)	% Change
Milk	54,557	- 4
Beef	10,152	+36
Veal	208	-50
Lamb and mutton	246	-23
Pork	6,177	+10
Turkey	1,100	+44
Broiler	5,206	+58
Eggs (no.)	69,804	+ 9

Higher demands for both beef and nonruminant livestock products will result in increased demand for forages in two ways: 1) By increased numbers of beef animals and 2) by the inevitable substitution of high quality forage for concentrates in ruminant diets as concentrate prices increase. At the present time, considerable amounts of concentrate are fed to dairy and beef animals (Table 4). Concentrates made up 16% of beef and 37% of dairy animal diets. Therefore, replacement of concentrates by forage will greatly add to total forage demand.

Table 4. Forage and concentrate consumption by livestock in the U.S. in 1974. Data are in millions of tons of feed units.^{1/} (Adapted from Hodgson 1977).

	Total Concentrate	Total Forage	% Forage
Dairy	26.2	46.0	63
Beef	36.6	189.4	84
Sheep and goats	0.8	6.7	90
All livestock	174.0	264.8	60
% by ruminants	36	91	

^{1/} A feed unit is the nutritional equivalent of 1 pound of corn.

Yields of Forage and Grain

Land resources needed to provide projected forage demand in the future will also be sought for grain crop production. The comparative economics of forage and grain production will ultimately determine how the land resources will be used. Most of the crop land pasture and some of the land devoted to hay production on U.S. farms is poorer in condition and less fertile than that used for corn and other feed grains. Under these conditions highest returns of energy and protein may be obtained from forage rather than grain crops. Table 5 compares representative production data for corn and alfalfa from moderately productive crop land subjected to good management. Yields of dry matter and crude protein were highest when the land was managed for forage than when managed for grain. Although these results may not represent all crop land now in pasture, they emphasize that grain production may not be the most efficient agricultural system for all lands now classified as crop land.

Table 5. Comparative dry matter yields and crude protein from forage and grain crops grown on moderately productive land with good management (Adapted from Cast Special Publ. No. 4).

Crop	Dry Matter	Crude Protein
	<u>Lb/A</u>	<u>Lb/A</u>
Corn grain	4830	493
Corn silage	7667	636
Alfalfa hay	6805	1177
Alfalfa silage	7387	724

Energy Costs

Requirements for fossil energy and energy costs will be a major factor in determining forage vs. grain production as prices of fossil energy increase over the next decades. Heichel (1973) calculated that fuel alone accounts for 47% to 56% of the total cultural energy expended for modern crop production. Fertilizers account for an additional 0.05% for soybeans to 19% for corn grain. There is little doubt that the efficiency of fossil energy use in agriculture will become more important to farmers and to the nation.

Table 6 lists digestible energy returned by various grain and forage crops in relation to fossil fuels expended for their production. Grain crops in the U.S. returned the least amount of digestible energy per unit of fossil fuel energy consumed (fossil fuel efficiency). Lowest efficiency of 1.8 was calculated for modern rice production in Louisiana. In contrast, rice production in the Philippines under a nonmechanized, labor intensive system of management achieved a fuel efficiency of 17.3. The difference in energy efficiency between the two rice production systems represents the cost of substituting mechanization in modern agriculture for hand production methods. The return for this added fossil fuel cost to the Louisiana farmer was a grain yield 3 times higher, and a labor requirement only 6.1% as high as that in the Philippines.

Table 6. Digestible energy content of economic yield per unit of fossil energy input for various crop production systems (Adapted from data of Reid 1975 and Heichel 1973).

Crop	Digestible Energy Fossil Energy Input ^{1/}
	(Mcal/Mcal)
Soybean seeds	2.0
Rice (Louisiana - 1970)	1.8
Corn grain	2.5
Oats	2.5
Corn silage	4.1
Hay	7.5
Grass silage	8.2
Rice (Philippines - 1970) ^{2/}	17.3
Pasture herbage	40 - 100

^{1/}Inputs include energy costs of machinery construction and repair, fuel, fertilizer, seeds, pesticides, drying, electricity, transportation, and food of workers.

^{2/}Major inputs are labor.

Similar effects of increased use of mechanization are evident for forage production. Forage harvested in the form of hay or silage produced 4.1 to 8.2 Mcal digestible energy per Mcal fossil fuel. This was 2 to 3 times more efficient than that of grain crops. Forage managed for pasture had energy efficiencies of 40 to 100, depending on the length of the grazing season. Values for range would undoubtedly be higher still. Rising energy costs over the coming decades will encourage a shift to less fuel intensive agricultural systems such as those involving forages.

Animal Feed Conversion Efficiency

Expanded use of animal based agricultural systems will depend on the efficiency with which various types of animals can convert consumed feed nutrients to desirable animal products. Table 7 contains relative efficiencies of conversion of feed nutrients to edible animal products by various classes of livestock. The dairy cow ranks highest among both ruminant and nonruminant livestock in efficiency of conversion of dietary nutrients to both energy and protein. During lactation almost 90% of the feed intake is converted to gross edible product. Nonruminants rank next highest in conversion of feed to food nutrients, while meat producing ruminants rank lowest. It is clear that during periods of severe grain shortage, it will be difficult to justify feeding grain to meat producing ruminants. Depending on the severity of the shortage, grain feeding to nonruminants may also be prohibitive. It is under these very conditions that the ability of grazing ruminants to produce quality protein from forage assumes major importance.

Table 7. Estimate of relative percentages of feed nutrients converted to edible animal products by various species (From R. E. Hodgson 1970).

Animal Product	Conversion to Energy	Conversion to Protein	Gross Edible Product Output as % of Feed Intake
	%	%	%
Milk	20	30	90
Beef	8	15	10
Lamb	6	10	7
Pork	15	20	30
Eggs	15	20	33
Broilers	10	25	45
Turkey	10	20	29

Table 8 compares the efficiency and energy cost of protein production from various sources under "intensive" and "extensive" management systems. Present day production practices are representative of the intensive system where grains make up a significant part of animal diets and fossil energy plays a major role in crop production. Of the animal products, milk requires

Table 8. Efficiency of protein production under intensive and extensive management systems (From Reid 1975).

Food Source	Intensive ^{1/}		Extensive ^{2/}	
	gm Protein Mcal DE	Energy Subsidy	gm Protein Mcal DE	Energy Subsidy
		Mcal/kg		Mcal/kg
Milk	12.8	14.9	12.8	6.3
Beef	2.7	53.6	2.4	31.6
Pork	6.2	66.7		
Corn grain		15.7		
Soybeans		6.0		

^{1/} Concentrates providing 25%, 80% and 100% of DE to dairy cows, feedlot cattle, and pigs, respectively, after weaning.

^{2/} All forage diets to dairy and beef after weaning.

the least subsidy of fossil energy and is most efficient at using dietary digestible energy for protein production. Beef and pork are inefficient in these processes. The energy subsidy for protein production in milk was slightly lower than that for corn production, but was still considerably higher than the subsidy for soybean protein.

In the extensive management system, beef and dairy are fed all forage diets from grazed and harvested forage. The fossil energy required to produce milk and beef protein was considerably lower than for the intensive system. The subsidy for milk protein was similar to that for soybean protein in the intensive system. The energy subsidy for beef protein in the extensive system is still high compared to plant protein. However, beef systems provide a mechanism whereby low quality forages from pastures, crop residues, and food and feed by-products can be converted to edible food.

Developing Forage Technology

At the present time, utilization of crop residues and cellulosic by-products from industry for beef production is limited. Research on modern day production systems utilizing these forage resources has only recently been initiated. Harvestable grain represents only about half of the above ground dry matter of most grains. The remaining residue represents a vast resource potential for conversion to edible food by ruminants.

There undoubtedly exists today the potential to develop artificial cellulose digestion systems. Certain crop and many industrial residues could serve as an energy source for microbial conversion to edible food. It is doubtful that such a technology, even if highly efficient, would replace ruminant animals, however, because of the cost of gathering and transporting low value residues to centrally located digesters.

Extraction of plant leaf protein for human consumption will probably be an important food industry by the end of this century. The concept isn't a new one as research on leaf protein concentrates has been in progress in various countries for thirty years (Pirie 1971). Pilot plants implementing this developing technology are already in operation (de Fremery and Kohler 1975). The fibrous residue remaining after the soluble plant proteins are extracted contains 76% of the original plant dry matter and makes excellent silage. Chemical composition, silage quality, and dairy cow performance were shown to be similar between protein extracted alfalfa residue and low-moisture alfalfa silage (Ream et al. 1975). Utilization of the fibrous residue is an important part of the leaf protein concentrate system.

Other Expected Developments

Due to the increasing value of harvested forage and the demand for high energy forage in the future, production systems now in use will be improved. New machine designs will be developed to reduce energy requirements for forage harvesting and storing. Methods will be devised to significantly reduce dry matter and quality losses during harvest, storage and feeding. Rapid methods of assessing forage quality will gain widespread use in the near future. Quality analysis will form the basis for marketing and feeding forage. Forage yields will increase over the next 20 years, but no major yield breakthrough will probably be obtained because of the genetic complexity and diverse nature of forages.

Conclusions

1. Ruminant animals will remain an important part of the food production system because of their ability to convert forages, crop residues, and industrial cellulosic by-products to edible food.
2. Demand for high quality forages will increase over the entire period as availability of concentrates for animal feeds declines.
3.
 - a. Strong pressure will develop to go from intensive to extensive forage utilization systems.
 - b. Extensive beef systems will be common in 10 years.
 - c. Few intensive systems will exist in 20 years.
 - d. Beef animal numbers will increase over the entire period.
 - e. Crop residues will form a major feed source for beef systems.
 - f. Dairy management will remain intensive over the period.
4. Most forage crops will be shifted to less fertile soils to make room for grain crops by the end of this century. Corn as forage will still be an important feed source for dairy systems.

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Forage-Animal Systems for Efficient Raising of Calves .

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Forage-animal systems are being evaluated for beef calf production and herd maintenance. The forage systems are: (A) bluegrass-white clover (Poa pratensis L.-Trifolium repens L.) for April to December pasture and alfalfa-orchardgrass (Medicago sativa L.-Dactylis glomerata L.) for hay, herd and creep grazing, (B) bluegrass-white clover for April to December pasture and tall fescue-red clover (Festuca arundinacea Schreb.-T. pratense L.) for hay, herd and creep grazing and autumn stockpiling for winter grazing, and (C) same as (B) except tall fescue-ladino clover for pasture. There are two calving seasons for the Aberdeen Angus cows for each forage system (fall = Sept. to Nov. and winter = Jan. to Mar.), two stocking rates (9 cows/7.3 ha and 6.1 ha) for (A) and (B) and one stocking rate (9 cows/6.1 ha) for (C). Each system is divided, 56% and 44% for the April to December pasture and hay or winter grazing, respectively. Each system is managed for optimum forage and cattle production. In (A) the herds are wintered on the bluegrass-white clover pasture. Alfalfa-orchardgrass hay for winter calving cows is fed at a 5.9 kg/cow daily until February 1 and then 9.5 kg until spring pasture. The procedure is reversed for fall calving cows. Fall born calves receive alfalfa-orchardgrass hay ad libitum during winter on (A) and on (B) and (C) graze stockpiled fescue-red clover and receive fescue-red clover hay ad libitum when needed. Winter born calves receive no feed prior to spring pasture other than that available to the cows. Cows remain on a system until removed for reproductive failure or other health reasons. Maintenance P and K fertilizer is 0-34-65 kg/ha annually for the tall fescue-red clover and bluegrass-clover and 0-44-84 plus 30 kg borax/ha for alfalfa-orchardgrass. In addition, the fescue-red clover receives 78 kg N in August. The red clover is broadcast overseeded (5.6 kg/ha) each March. Autumn growth has averaged 4,783 kg/ha (86.5% dry matter) hay equivalent and 85-90% of available forage is utilized. Winter calving cows on (B) light stocking and (C) have grazed year-round for three consecutive years. System (B) heavy stocking, fall and winter calving and (C) fall calving have needed hay each winter in addition to the stockpiled fescue. Daily weight losses have been similar for (B) winter calving cows grazing stockpiled fescue (heavy and light stocking) (0.70 kg) and for fall calving cows (B) and (C) heavy stocking (0.60 kg). Body weight losses for cows (A) winter and fall calving have been 0.64 and 0.52 kg, respectively. Body weight losses have been regained on all systems during summer grazing except for winter calving cows on (C) whose April to July gains are slower and average body weight tends to decline annually. No reproductive problems have been encountered related to forage system, calving season or stocking rate. Average daily gains 0.80 kg (birth weight excluded) and weaning weights 254 kg for winter born calves have been similar for (A) and (B) and stocking rates. Daily gains have averaged 0.78 kg and weaning weights 227 kg for (C). Fall born calves have responded to forage systems similar to winter calves with daily average gains (0.06 kg) and weaning weights (4.0 kg) lower than for winter born calves. Lower daily gains for fall born calves are not fully reflected in weaning weights due to a longer suckling period made possible by ample spring forage. A creep grazing procedure has provided high-quality grazing for winter and fall born calves. Alfalfa stands have diminished under creep grazing. Pesticides limit flexibility in creep grazing alfalfa in spring. A higher stocking level is indicated for (C) than (B) but lower gains can be expected for winter or fall born calves.

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Forage Systems for Fattening Steers with a Minimum of Grain Feeding .

H. T. Bryant, R. C. Hammes, Jr., R. E. Blaser, J. P. Fontenot,
Frank McClaugherty, and Ralph Kline

Virginia Polytechnic Institute and State University, Blacksburg, Virginia

The forage systems are based on the following three grass-legume forages: (A) Kentucky 31 fescue (Festuca arundinacea Schreb.) and Kenstar red clover (Trifolium pratense L.) at 13 and 9 kg/ha, respectively, (B) Kentucky bluegrass (Poa pratensis L.) and Tillman ladino clover (T. repens L.) at 17 and 2 kg/ha, respectively, and (C) Virginia 70 orchardgrass (Dactylis glomerata L.) and Weevlchek alfalfa (Medicago sativa L.) at 6 and 17 kg/ha, respectively. Together these forage mixtures provide year-round grazing. The fescue-red clover mixture is grazed during the winter months, harvested for hay during the flush spring growth, grazed, and beginning in early August allowed to accumulate for winter grazing. The Kentucky bluegrass-white clover mixture is grazed during the spring, summer, and fall. Alfalfa-orchardgrass when not needed for supplemental pasture is harvested for winter feed. The relationship between the opportunity for selective grazing and live weight gains per animal and per hectare is being studied. Five groups of cattle rotationally graze the forage mixtures, two of the five groups of cattle rotationally graze approximately half of the canopy (first grazers), and the remaining three groups of cattle rotationally graze nearly all of the whole canopy (typical rotational grazers). Therefore, the 'first grazers' have a greater opportunity for selective grazing than the 'whole canopy grazers.' The effect on live weight gains of the cattle when fed shelled corn on pasture at 0, .5, and 1% of their body weight is being evaluated. The live weight gains of calves 9 months old, average weight at start of experiment 249 kg, grazing four forage systems were compared with live weight gains of yearlings 13 months old, average weight at start of experiment 261 kg, grazing three forage systems. The average daily live weight gains of first grazers without corn supplements grazing fescue-red clover from November to May were .64 and .87 kg per day for the calves and yearlings, respectively. The same calves and yearlings rotationally grazing bluegrass-white clover and fescue-red clover pastures without corn supplement, from May to July 19, had average daily live weight gains of .67 and .58 kg, respectively. For calves rotationally grazing the whole canopy of fescue-red clover, not supplemented with corn, average daily live weight gain was .74 kg for the period November to May. Their average live weight gain was .66 kg for May to July 19, when Kentucky bluegrass-white clover pastures were included in the grazing rotation. Calves and yearlings rotationally grazing the whole canopy of fescue-red clover supplemented with corn at .5% of their body live weight during November to May gained an average of .67 and .89 kg a day. Increasing the corn level to 1% of their body live weight, while rotationally grazing Kentucky bluegrass-white clover and fescue-red clover from May to July 19 gave an average daily live weight gain of 1.08 and 1.29 kg for the calves and yearlings, respectively. Calves (first grazers) on stockpiled fescue-red clover, supplemented with corn at .5% of body weight, had average daily live weight gains during November to April of .91 kg; the same calves, rotationally grazing Kentucky bluegrass-white clover and fescue-red clover from May to July 19, had average daily live weight gains of .93 kg. The average daily gain was .94 kg and carcass grade was 'average good' for yearling steers slaughtered in May after grazing stockpiled fescue-red clover, supplemented with grain at 1% of their body live weight from November. Slaughter data will be obtained on yearlings in July and weanlings in October and February.

2-14 Progress in Developing Al-Tolerant Alfalfa [3

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[Aluminum] toxicity is believed to be a factor restricting root growth in the acid subsoils of the Eastern U.S. Alfalfa is normally a deep-rooting crop capable of utilizing both moisture and minerals in the lower soils, thereby resulting in high levels of production even during short periods of drought. Where toxic levels of aluminum occur, effective rooting is prevented and alfalfa production is disappointing. Liming of the surface soils has little effect on the acidity of the subsoils. Development of Al-tolerant alfalfa is the logical solution.

Screening of Arc-related germplasm for tolerance to low pH Al-toxic conditions began in July 1973 in wooden flats filled with Tatum soil. Tatum soil is characteristically low in pH (4.0-4.5) and contains toxic levels of Al. Approximately 3,000 seedlings were screened. After 2 weeks, seedlings with the most vigorous root systems were selected, were allowed to interpollinate, and seed was collected. A second cycle of screening was conducted in February 1974 and seed was subsequently produced.

For the screening of the third cycle, a nutrient solution culture technique was used. Approximately 3,000 seedlings were grown in nutrient solution adjusted to pH 4.2-4.5 with 3 ppm Al. After 4 weeks, the tallest, most vigorous seedlings were selected and intercrossed seed was produced.

Following the three cycles of screening, an evaluation of the progress of our screening was conducted in 1976, using the nutrient solution culture technique. Entries included the original population, cycles 1, 2, and 3, and Williamsburg as a check. Results indicated that when grown at pH 4.2-4.5 with 3 ppm Al, plant heights, top weights, root lengths, and root weights of cycle 3 seedlings were 35-67% greater than those of the original population. Although gradual progress was noted for cycles 1 and 2, particularly in root length and weight, the greatest progress toward Al tolerance was made in cycle 3. Seedling growth of Williamsburg was generally poorer than the original population.

Screening of cycle 4, using the nutrient solution technique, has recently been completed. In addition to laboratory evaluations, field plots will be established with cycle 4 seed in Al-toxic soils in Virginia in 1977.

Measuring N Fixation in Seven Alfalfa Cultivars,

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An isotope dilution method was used to detect differences in N fixation among seven alfalfa cultivars and also among plants within cultivars. Plants were grown in the field in soil-filled cement cylinders 61 cm (24 inches) in diameter. Three cylinders (reps) were used for each cultivar. The soil in each cylinder had been previously labeled by incorporating ^{15}N into soil organic N. The isotopic composition of the mineralized soil N was determined from the N uptake by a non-fixing plant, tall fescue, grown in each cylinder. Any decrease in the respective isotope ratio in the alfalfa plants was attributed to fixation of atmospheric N.

In 1976, all of the alfalfa plants in a given cylinder were bulked and analyzed together for the first three harvests, but were analyzed individually for the fourth harvest.

N fixation rates averaged across cultivars were not significantly different between harvests 1 and 3, with 61 and 65%, respectively, of the nitrogen present in the plant tops attributed to fixation. However, harvest 2 was significantly lower, with 55% fixation, possibly due to severe drought conditions resulting from our failure to supply sufficient moisture during hot, dry weather.

Significant differences in N fixation were found among cultivars. Vernal, Ranger, Saranac AR, Arc, and Moapa 69 had 73, 70, 69, 66, and 65% fixation, respectively. They were not different from each other but were significantly higher than DuPuits and Lahontan, with 45 and 34% fixation. It is unclear why the latter two cultivars were lower in fixation. Each cultivar performed relatively well in one of the three cylinders; however, the other two cylinders were very poor in growth and N fixation. No harvest x cultivar interaction was observed. A highly significant correlation ($r = 0.73$, $n = 63$) was obtained between forage yield and percent N fixation.

A highly significant correlation ($r = 0.53$, $n = 199$) between forage yield and percent N fixation was also obtained for the plants of Arc, Saranac AR, Ranger, Vernal, and Moapa 69 which were cut, weighed, and analyzed individually in harvest 4, indicating that the larger plants are related to higher levels of N fixation. Percent N fixation ranged from 43.7 to 93.4 for the 199 plants analyzed. Our results suggest that, although alfalfa cultivars presently fix two-thirds to three-fourths of their N from the atmosphere, significant variation in N fixation exists and progress toward breeding more efficient N-fixing cultivars should be possible.

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Initiation of a Work Program to Isolate Disease
Resistance in Alfalfa in the Republic of Argentina

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With the exception of bacterial and possibly Verticillium wilt, the same alfalfa diseases can be found in the Republic of Argentina as occur in the U.S. Diseases, insects, and some physical factors are believed to be the cause of a decline in hectarage, longevity and productivity of existing alfalfa stands. At the present time, the Food and Agriculture Organization and the Republic of Argentina are engaged in a joint project "Recovery of Alfalfa Productivity" in an attempt to reverse the trend.

During the period 18 August-30 October 1976, staff scientists and I conducted limited surveys to determine the extent of diseases in the country and to select a disease amenable to control by improved management, or by breeding for resistance. The crown and root rot problem is their most important disease but its complexity ruled it out as a problem with a ready solution. As a group, blackstem diseases and anthracnose appeared to be second ranked in importance, followed by other foliar diseases, stem nematode, and all other diseases.

Anthracnose was selected for immediate attention since screening for resistance to this disease is quickly and efficiently accomplished in the seedling stage. Resistance evaluations of 12 Argentine and 17 U.S. cultivars were conducted at Anguil, Argentina, in a series of three inoculations. Percentage survival for the entries ranged from 0 to 86% with the U.S. cultivars Arc (86%) and Saranac AR (65%) having the greatest survival. In general, Argentine alfalfas were quite susceptible, ranging from 0 to 18% survival. However, it was concluded that a phenotypic recurrent selection program for anthracnose resistance in Argentine alfalfas would be highly successful.

Contributions of Resistance to Anthracnose, Bacterial Wilt and
Phytophthora Root Rot to Persistence and Yield of Alfalfa
under Irrigation.

G. R. Buss

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Previous experience with alfalfa, primarily the Williamsburg variety, has shown that persistence is very poor under irrigation. It was assumed that the irrigation made more favorable conditions for development of diseases and the consequent thinning of stands. However, it was difficult to determine which diseases might be most detrimental.

In 1974 an experiment was planted at Orange, Virginia, with the objective of determining the relative importance of three diseases--anthracnose, bacterial wilt and Phytophthora root rot--in stand depletion under irrigation. Twenty-one varieties with various degrees of resistance to different combinations of the three diseases were planted in broadcast plots. The experimental design was a split plot with irrigation vs. no irrigation as the main plot treatments and varieties as sub-plots. Eighteen and 40 inches of water were applied in 1975 and 1976, respectively. No water was applied before first harvest in any year. The data collected included yields (4 harvests/year) and plants per square foot (once each season).

Irrigation effects were not significant in 1975 and 1976 but were in 1977, due to a carryover of soil moisture from irrigation in late 1976 and probably a better overwintering condition of the plants. All other harvests except the last one in 1975 showed significant yield increases from irrigation. Significant plant stand differences due to irrigation were not detected until 1977.

Variety differences were significant for all data except the 1975 first harvest. The irrigation x variety interaction was not significant for any yield data and was significant at the 10% level for plant stand data in 1976 only. This information would indicate that all varieties behaved similarly under irrigation. However, closer observation of the data revealed some trends from which tentative conclusions could be drawn. Resistance to anthracnose appeared to have the largest effect on persistence and yield with Phytophthora root rot having somewhat less effect. Bacterial wilt did not appear to be present since wilt symptoms were not observed and the performance of wilt susceptible varieties was similar to resistant varieties.

245 Ecological Factors Influencing Infection and Development of
Colletotrichum trifolii in alfalfa

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Anthracnose limits alfalfa production in southeastern and mideastern USA. Generally the Flemish alfalfas are susceptible, but procedures have been developed for screening populations and resistant cultivars are available. Recent studies evaluated the effects of temperature and light on infection and disease development, the effects of temperature on resistance, and how culture age affects spore viability. Three-week-old plants (cultivar 'Team' unless stated otherwise) were inoculated with C. trifolii (10^6 spores/ml) and incubated 1-3 days at 100% RH. After 3 weeks, plants were given disease scores of 1-5; 1 and 2 resistant, 3, 4, and 5 susceptible. A disease severity index (DSI) and a survival percentage (score 1 & 2) were determined. Experiments included 4 to 9 replications and each experiment was repeated.

In the first study, inoculated plants were incubated at 16 or 24 C during infection and moved to growth chambers at 14/10, 18/14, 22/18, 26/22, and 30/26 C day/night temperatures for disease development. The DSI was significantly larger ($P = 0.01$) when infection occurred at 24 (4.3) than at 16 C (3.9) and significantly increased ($P = 0.01$) when the infection period increased from 1-3 days (3.5, 4.3, and 4.5, respectively). The DSI of plants at 5 temperatures for disease development ranged from 4.0 to 4.2 and were not statistically different. Temperature influences anthracnose more during infection than during disease development.

The effects of 3 combinations of light intensity during infection and disease development were studied in 2 combinations of temperatures. The DSI of plants incubated at 26.4, 7 and 1.6 Klux during infection were 3.3, 3.4 and 3.4, respectively, and were not statistically different. The DSI of plants incubated for infection at 26 C day/22 C night and 14 C day/10 C night were 4.1 and 2.4, respectively, and were different statistically ($P = 0.001$). The DSI of plants incubated at 26 C day/22 C night and 14 C day/10 C night during disease development were 3.4 and 3.2, respectively, and were not different.

Three resistant and 2 susceptible cultivars were inoculated and incubated at 16 or 24 C for infection. The DSI for all cultivars but one was larger at 24 than at 16 C (DSI of Arc was 2.3 at both temperatures). The average DSI of Team and Saranac were 4.4 and 4.7, respectively. DSI of 'Arc', 'Saranac AR', and 'Victor' were 2.3, 2.6, & 2.4, respectively.

The virulence of C. trifolii isolates from North Carolina (NC) and Pennsylvania (PA) was compared using 6 susceptible and 6 resistant alfalfa cultivars. Survival of resistant cultivars averaged and ranged, 58% and 45-76%, and 60% and 46-81% for NC and PA isolates, respectively. The survival of susceptible cultivars averaged and ranged 3% and 0-8% and 5% and 0-14% for NC and PA isolates, respectively.

Germinability of C. trifolii spores from cultures 5 to 25 days old was determined after incubation at 24 C for 48 hours. Also, survival was determined for Saranac and Saranac AR seedlings inoculated with spores from these cultures. Spore germinability from cultures 5 to 11 days old averaged 33% and ranged 27-42%; germinability of spores from 13- to 25-day-old cultures averaged less than 1%. Seedling survival of both cultivars increased when inoculated with spores from cultures of increasing age.

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Effect of Different Levels of Expression of the Multifoliolate Character and Leaf-Stem Ratio on Forage Quality and Performance of Alfalfa Synthetics .

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Six experimental synthetics developed from parental clones previously screened for leaf-stem ratio (leaf %), multifoliolate expression (ML), and yield were evaluated to determine the effect of leaf % on the forage quality and performance. Parent clones were grouped to give synthetics with the following characteristics: 1) ML - high leaf %, 2) ML - low leaf %, 3) ML - high leaflet number, 4) ML - low leaflet number, 5) trifoliolate - high leaf %, and 6) trifoliolate - low leaf %. Cage-produced seed was used to establish broadcast seeded plots in 1972, and these were harvested on a 3-cutting schedule in 1973, 1974 and 1975. Leaf %, crude protein content (CP), and in vitro true digestibility (IVTD) were determined for each harvest in 1974 and 1975.

Significant differences in leaf % were observed among entries in each harvest in 1974 and 1975. Significant differences in IVTD and CP were measured among entries for 2 of 3 harvests in both 1974 and 1975. Variation among entries was strikingly less for IVTD and CP than for leaf %. Check varieties, Saranac and Iroquois, tended near the mean of the range of entry values.

IVTD was correlated with leaf % for 4 of 6 harvests. Regression coefficients ranged from .10 to .43 and approximated .30. These suggest that about a 3-unit change in leaf % is needed to effect a 1-unit change in IVTD. CP was also correlated with leaf % for all harvests in 1974, but not in 1975. Regression coefficients ranged from .04 to .29. Average values indicate about a 5-unit change in leaf % is needed to effect a 1-unit change in CP.

Synthetics with high leaf % or strong expression of the multifoliolate character were distinctly lower yielding than Saranac and Iroquois. Strong selection has probably narrowed the germplasm base of these synthetics.

It is apparent that average leaf % can be altered, but rather dramatic changes in leaf % are necessary to effect economically important gains in IVTD or CP. The use of leaf % as a primary selection criterion for nutritional quality does not exploit genetic variation in the composition of the stems which are the major forage component. Breeding for improved nutritional value in alfalfa should probably be based on screening techniques such as IVTD, cell wall or crude protein determinations which reflect nutritional value of the whole plant. Expected gains in nutritional value are small; therefore yield potential must be maintained through the use of large diverse parent populations.

The Present Status of Verticillium Wilt in the United States.

J. H. Graham, R. N. Peaden, D. W. Evans, and J. H. Elgin, Jr. Formerly PPHI, ARS, USDA, Beltsville, Md. (now Waterman-Loomis Co., Columbia, Md.); ARS, USDA, Prosser, Wash.; Washington State University, Prosser, Wash.; and Field Crops Laboratory, PGGI, ARS, USDA, Beltsville, Md., respectively.

Verticillium wilt of alfalfa, caused by the nonsclerotial fungus Verticillium albo-atrum, has been found in the United States. The prevalence and importance of the disease in this country have not yet been determined. However, the fungus was isolated from chlorotic and wilting plants in central and western Washington and north central Oregon during 1976 and early 1977. The disease has been known in Europe since 1918. Frequently, stands are non-productive by the end of 2 or 3 years.

Typical symptoms of Verticillium wilt include yellowing of leaves which later become whitish and desiccated. In the advanced stage of the disease, plants are noticeably stunted. Internally, the xylem tissues become orange-brown. The fungus is difficult to isolate from roots but is easily recovered from infected stems, petioles, and leaves. In the field, Verticillium wilt is difficult to distinguish from Fusarium wilt.

In inoculation tests at Beltsville, Md., and Prosser, Wash., resistant European cultivars were found to be resistant; U.S. cultivars were susceptible. A composite of approximately 30 U.S. cultivars selected for resistance to Verticillium wilt in Italy (PL 480 Project) had a low level of resistance. There was a negative correlation between plant vigor and internal root discoloration.

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Effect of Root Lesion Nematodes on Yield of Forage Legumes and Grasses
Seeded Alone and in Mixture

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The effects of the root lesion nematode, [Pratylenchus penetrans] on yield of forage legumes and grasses seeded alone and in mixture were studied in the greenhouse and field. Nematodes were controlled in the greenhouse by methyl bromide fumigation or by phenamiphos treatment prior to seeding and in the field by a pre-plant application of phenamiphos. Forage yields of alfalfa, red clover, and birdsfoot trefoil seeded alone were reduced significantly by nematode infestation, while yields of timothy and brome-grass seeded alone were unaffected or reduced slightly only. Yield of legume-grass mixtures was reduced significantly and generally of the same order as the legume species in the mixture. The yield of legumes in legume-grass mixtures, however, was reduced more by nematode infestation than when the same legume was seeded alone. At the same time, the yield of grasses was substantially greater in legume-grass mixtures growing in nematode-infested soil. The differential effects of the nematode on legumes and grasses resulted in a significantly higher proportion of grasses as components of mixtures when large numbers of nematodes were present.

BUSINESS MEETING

Second Eastern Forage Improvement Conference

J. O. Keller Conference Center
The Pennsylvania State University
University Park, Pennsylvania

July 15, 1977

The meeting was called to order at 1:20 p.m. by Chairman Heinz Gasser. Minutes of the first Eastern Forage Improvement Conference held July 16-18, 1975, at the University of Guelph, Guelph, Ontario, Canada, were not read but were approved as printed in the proceedings of that conference.

The following committees were appointed by Chairman Gasser:

Nomination Committee

John Baylor, Chairman
Dick Hill
Harry Bryant

Resolutions Committee

Glenn Buss, Chairman
Norman Lawson
Jim Elgin

There was no old business so the meeting was opened for new business.

There was considerable discussion regarding the possible affiliation of the EFIC with the Northeast ASA. Some members felt the EFIC was not sufficiently large and all-encompassing to justify the travel, meeting arrangements, etc., and suggested that an affiliation with another group, like NE-ASA, would increase attendance and participation while reducing the administrative chores. Others felt that an affiliation with another group was not desirable at this time; however, they would consider the possibility of an occasional summer meeting with a regional technical committee every second or third meeting. Dick Hill moved, seconded by Ken Leath, that the conference not affiliate with any other group and leave EFIC as it now exists. Motion passed.

Dick Hill discussed proposed changes in the contents of the Eastern Alfalfa Nurseries Report and the way it is compiled and distributed. He proposed that the report be expanded from alfalfa alone to include all cool-season forages in keeping with the recent change in the name of our conference. Also proposed was that he compile and distribute the report only for the Eastern United States and that the forage crops committee for each Canadian Province send out the report for their own Province. Thirdly, he proposed that he maintain the mailing list for the entire Eastern Forage Improvement Conference and run off all labels for distribution of the U.S. and Canadian reports. The mailing labels would be sent to appropriate persons responsible for distributing the reports. These proposed changes will expand the content of the nurseries reports and greatly facilitate their distribution. The conference unanimously approved these changes. The conference secretary will request from the Canadian representatives the mailing lists used for distribution of their reports. These mailing lists will be provided to Dick Hill.

A note was read from Don Barnes, secretary of the National Alfalfa Improvement Conference, indicating that the 26th NAIC will be held at South Dakota State University, Brookings, S. Dak., June 6-8, 1978. The executive committee will meet at the Agronomy Meetings in Los Angeles on November 15 to develop program plans. A letter will be sent to members in late November announcing program plans and asking for volunteer papers. Any program planning suggestions should be communicated to Morris Decker, Jim Elgin, Mel Rumbaugh, or Don Barnes prior to November 10.

Regarding future EFIC meetings, a suggestion was made from the floor that speakers be asked to bring summaries of their papers for distribution to the audience instead of having to wait for publication of the proceedings.

Committee Reports

Nominating Committee - The nominating committee proposed the following slate of officers:

Chairman	- Morris Decker, University of Maryland, College Park, Md.
Vice Chairman	- Jim Elgin, USDA, Beltsville, Md.
Secretary	- Jack Winch, University of Guelph, Guelph, Ont., Canada

Nominations were closed and a unanimous ballot was cast for the nominees.

Resolutions Committee - The resolutions committee submitted the following resolution:

Whereas Dr. R. R. Hill, Jr., and others from the U.S. Regional Pasture Research Laboratory in cooperation with members of The Penn State University Agronomy Department served as hosts for the second Eastern Forage Improvement Conference, including doing an outstanding job of making local arrangements for the conference, the field tour, and picnic, be it resolved that we, the participants of the conference, extend our sincere thanks to these individuals for their efforts in making our stay at Penn State enjoyable and productive.

The resolutions committee report was unanimously approved.

Meeting Location - No invitation for the third EFIC had been received; however, meeting somewhere in Canada was suggested. Also mentioned was the University of Maryland in conjunction with the Beltsville Agricultural Research Center. The executive committee will make the final decision on the meeting location.

The business meeting was adjourned at 2:03 p.m.

James H. Elgin, Jr.
Secretary, Second Eastern Forage
Improvement Conference

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